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Employing community question answering for online discussions in university courses: Students' perspective

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ABSTRACT

In university courses as well as in MOOCs, Community Question Answering (CQA) systems have been recently recognized as a promising alternative to standard discussion forums for mediating online discussions. Despite emerging research on educational CQA systems, a study investigating when and how to use these systems to support university education is still missing. We stress that such a study should effectively take into account students' perceptions of CQA systems rather than relying solely on an analysis of their effective usage based on data available in system logs. This paper therefore systematically analyzes perspective of 182 computer science students from three universities located in three different countries on concept of educational CQA systems. Students' opinions were collected using a questionnaire that was designed to assess conceptual issues of using CQA systems in university education, their core features as well as particular implementation of our CQA system Askalot. The analysis of collected responses based on non-parametric statistical tests revealed that there are various significant differences in the perception of CQA systems between different types of students (e.g. passive and active) and in different deployment settings (e.g. when using CQA in a small number of 1–3 courses during one academic year or in 50 courses for 5 years). The obtained findings supported by content and usage analysis finally resulted into the summary of 12 main characteristics of CQA systems which describe their suitability for mediating online discussions in different deployment settings and for different types of students.

1. Introduction

Online discussions represent a crucial place for knowledge exchange in all kinds of learning communities either gathered around university courses or MOOCs (Massive Open Online Courses). There is a wide consensus based on many studies that collaborative learning, peer tutoring and social learning, which occur in online discussions, have a relation with better learning outcomes, wider participation of students or better grades, in general (Almatrafi & Johri, 2018), (Palmer, Holt, & Bray, 2008) as well as specifically in computer science (CS) education (La Vista, Falkner, & Szabo, 2017), (Mihail, Rubin, & Goldsmith, 2014).

Traditionally, *discussion forums* have been used to handle online discussions at universities (e.g. Moodle forum) or in MOOCs (e.g. built-in discussion forums used by Coursera or edX). Researchers (e.g. Alario-Hoyos, Perez-Sanagustin, Delgado-Kloos, Parada, and H.

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AMunoz-Organero (2014)) as well as course instructors (e.g. instructors at *CS50's Introduction to Computer Science* course[1]) are experimenting with various other social tools, which can serve as an appropriate alternative to discussion forums and which will be more efficient for their specific settings. Namely, chatrooms, social networking sites or community question answering systems are mostly employed besides other more specific tools, such as classrooms interactive presentation platforms (Triglianos et al., 2017). This trend is currently present particularly in CS education.

One of motivating factors for finding alternative social tools for handling online discussions is the fact that standard forums have both positive and negative qualities, while in some circumstances their drawbacks can be quite substantial. In some university courses and MOOCs, discussions can be characterized by very diverse topics, a large number of participants, who in advance may have various motivations for participation. This can be illustrated well on CS courses, which are many times quite specific in terms of larger and more diverse communities of students, more logistical and fact-based questions, or a higher participation rate (Vellukunnel et al., 2017). All these factors in connection with a long-term forum usage can lead to overwhelming and disorganized environments (Almatrafi & Johri, 2018). In our previous work (Ivanović, Xinogalos, Pitner, & Savić, 2017), we analyzed usage of various TEL (Technology Enhanced Learning) tools (forums being one of them) in three different countries and confirmed that students in programming courses do not tend to use forums despite the fact that they consider online discussions as very important.

In addition, previous analyses (e.g. Breslow, L., Pritchard, D. E., DeBoer, J., Stump, G. S., Ho, A. D., Seaton (2013)) have shown that the majority of contributions in discussion forums are created by a very small proportion of all students (the most active of them are called hyper-posters). Active contributing of new posts is not, however, the only way to use an online discussion tool - typically another significantly larger part of a community consists of more passive users (so-called lurkers) who prefer only to read and monitor discussions. Forums do not provide many features to support this kind of passive knowledge consumption (for example by favoring/bookmarking discussions or watching categories to get notifications about their new content).

Moreover, a recent study on MOOC discussion forums by Poquet, Dowell, Brooks, and Dawson (2018) showed an interesting trend - some forums evolved from social spaces for learning into smaller on-task question and answer spaces, which are not capitalizing on the opportunities for social learning. Discussion forums are not very appropriate and effective to handle this kind of discussions. On the contrary, *Community Question Answering* - CQA systems are fundamentally based on the question-answer concept and thus they seem to be a promising alternative to standard discussion forums.

In CQA systems (such as Stack Overflow, Quora or Yahoo! Answers), people can seek information by asking a question and share knowledge by providing an answer to questions asked by the rest of the community. In comparison with discussion forums, CQA systems have more structured content around questions and answers, they provide more possibilities for collaboration (e.g. best answer selection) and in addition, they are more community-driven (e.g. they provide community profiles and a possibility to follow activity of other users). In CS education, students are already familiar with the concept of CQA systems mainly due to a successful and popular Stack Overflow system, which is focused on a wide range of topics related to computer programming. Education of computer science thus naturally becomes an area where CQA systems are adopted firstly.

Proceeding from analyses of related work on educational CQA systems (see Section 2), to the best of our knowledge a study on employment of CQA systems in university courses is still missing. In addition, existing research on educational CQA systems is mostly based on the analysis of their effective usage, while students' perceptions on these novel discussion tools remain unresearched completely. We would like to emphasize that we should reflect and understand students' perspective and do not rely solely on usage analysis based on data in system logs.

In this paper, we therefore analyze not only data but also opinions and attitudes of students, who are grouped by their various characteristics, regarding conceptual issues of educational CQA systems, their core features and our particular implementation of CQA system named Askalot. On the basis of obtained findings, we consequently derive the main characteristics of educational CQA systems and specify settings in which these systems can be used (e.g. suitability for students with different group learning preferences or from different study years). These results are supposed to help: 1) researchers in further research on the promising concept of educational CQA systems; 2) university teachers, who are interested in adapting CQA systems, to decide whether these systems are suitable for their specific settings and requirements; as well as 3) developers and administrators to decide if advantages of CQA systems are worth integration into their TEL systems.

When conducting the study, we paid specific attention to limitations and future work directions that have been previously identified in the existing studies on online discussions: 1) At first, many studies (approx. 45%) are based on data from a single course and thus the results cannot be generalized easily (Almatrafi & Johri, 2018). 2) Secondly, most of studies focus on actively contributing students while omitting passive students, nevertheless online discussions are useful for them as well (Almatrafi & Johri, 2018), (La Vista et al., 2017). 3) Finally, it was recognized that consideration of various students' characteristics may lead to new interesting findings about discussions in CQA systems (Vellukunnel et al., 2017).

Our main contributions are as follows:

1. We present an in-depth mixed quantitative and qualitative study, which provides a new perspective on educational CQA systems employed in university courses by considering students' opinions rather than relying on system usage analysis only.
2. To obtain widely applicable findings, which are not based on a single source of data, we deployed our educational CQA system Askalot at three universities situated in three different countries. Consequently, we collected perceptions from a large number of 182 students from all three universities which used Askalot in heterogeneous deployment settings.

[1] https://www.edx.org/course/cs50s-introduction-computer-science-harvardx-cs50x.

3. The study purposefully involves also passive lurking students and compare their attitude to educational CQA systems with active students. In addition, we evaluate the appropriateness of the CQA concept also for students with various additional characteristics, such as online communication preferences, group learning preferences or study years.
4. Finally, we derive a set of main characteristics of educational CQA systems that allows us to specify under which circumstances it is suitable to use educational CQA systems to support communication in university courses.

The paper is organized as follows: we describe a novel concept of educational community question answering in Section 2. Section 3 introduces design and deployment of our educational CQA system Askalot. The experimental methodology is described in Section 4. The results from analyses of students' perceptions are provided in Section 5, which were consequently used to derive main characteristics of educational CQA systems in Section 6. Finally, conclusions are proposed in Section 7.

2. Educational community question answering

Due to the important role of online discussions in the educational domain, a relatively significant amount of research has already been conducted to study their various aspects. The recent survey by Almatrafi and Johri (2018) provides a comprehensive and systematic review of research efforts on discussions in online courses. The variety of addressed open problems and tasks includes analysis of participants' contributions, analysis of the interactions between participants or approaches to increase participation activity.

At the same time, there is a large body of research on CQA systems. CQA systems originally emerged on the open Web (e.g. Stack Overflow), where they became archives containing millions of answered questions. As a result they attracted the interest of many researchers. In our previous work, we reviewed 265 papers concerned with CQA systems and published a comprehensive survey and classification of research on CQA systems (Srba & Bielikova, 2016a).

Out of this extensive research on educational online discussions and CQA systems, only a very minor part concerns *educational CQA systems* specifically. It can be broadly divided into two parts: 1) designing educational CQA systems and 2) methods aimed to analyze and support interactions among students.

So far not many educational CQA systems were designed and developed. At first, Brainly[2] (together with OpenStudy (Ram, Ai, Ram, & Sahay, 2011), which was acquired by Brainly in 2016) is a large-scale open social learning environment which promotes knowledge sharing through Web 2.0 technologies. Besides CQA, it adapts concepts of social applications, such as forums, real-time chats and social networking sites. Brainly is currently the world's largest social learning community which specializes in online learning for students through asking and answering activities in 16 main school subjects (Le, Shah, & Choi, 2017).

While Brainly involves a great open community of students, remaining educational CQA systems are focused on smaller groups of students who are enrolled in the same course. Piazza[3] is a learning system that is directly inspired by CQA. It is an online platform which offers a refined question answering process along with key features for an effective course collaboration. It supports a student-to-student collaboration as well as student-to-teacher discussions. Another system, Green Dolphin, is a social question answering board designed to support the collaborative learning of programming (Aritajati & Narayanan, 2013). The important concept of Green Dolphin is that new questions are postponed and hidden from teachers for some time, so students have enough time to provide answers by themselves. Only if the question cannot be answered in the given time, a teacher is notified and asked to take a participation on a students' collaboration. Last but not least, also a universal StackExchange platform was used in edX course CS50.[4]

The gap between CQA systems based on open communities on one side and closed course-wide communities at the other side, is filled by our educational CQA system Askalot (Srba & Bielikova, 2015) which was designed specifically to support knowledge sharing in several courses at once (ranging from few courses up to many courses at the whole university, please, see Section 3 for more information).

The existing methods concerning educational CQA systems deal primarily with the quality of created content since high-quality questions and answers are crucial for successful learning. Quality of questions (Le, Shah, & Choi, 2016), answers (Choi et al., 2015) as well as low-quality content created by struggling users (Le et al., 2017) were examined. The study by Vellukunnel et al. (2017) analyzes content (question types) posted in the Piazza system by 560 students enrolled in CS2 courses provided by two universities. Another example of the related work is our method which supports students during the question creation process by automatic tag suggestions for their questions (Babinec & Srba, 2017).

Besides these quite specific approaches, there is a lack of broader studies aimed at the concept of educational CQA systems itself. In the context of MOOCs, the study (Alario-Hoyos et al., 2014) compared the use of CQA system with other social tools but does not provide more in-depth evaluation (e.g. in which settings it is appropriate to employ educational CQA systems). In addition, all previously mentioned works utilized data analyses only, while students' perceptions are not researched at all. While in the context of university courses, students' perspectives on standard forums have been previously analyzed (Ivanović et al., 2017), we are not aware of any similar work on educational CQA systems. In this paper, we attempt to fill this research gap.

[2] https://brainly.com/.
[3] https://piazza.com.
[4] https://cs50.stackexchange.com/.

3. Askalot - flexible and scalable educational CQA system

In our previous work (Srba & Bielikova, 2015), we designed and implemented the first educational and organizational CQA system Askalot.[5] It explicitly takes into consideration specifics of the educational domain (e.g. a teacher is fully involved in question answering and content evaluation) and university environment (e.g. students can ask questions closely related to their learning materials or even about organizational matters).

Askalot provides three groups of features: 1) essential features that are common with standard open CQA systems (e.g. posting questions and answers, voting, best answer selection); 2) education-specific features (e.g. highlighting of posts created by teachers); and finally 3) organization-specific features (e.g. content organization corresponds to formal structure of courses, users can follow their classmates or teachers).

The original design of Askalot was proposed specifically for Faculty of Informatics and Information Technologies of the Slovak University of Technology in Bratislava, Slovakia, where its first version was implemented and deployed, too. Therefore, it did not provide sufficient flexibility and scalability which was necessary to deploy Askalot in additional institutions. Our other motivation was also a cooperation with Harvard University in order to transform Askalot into a tool that can be used as a plugin to MOOC system edX. As the result, we rebuilt the original system design and following this process, we created several design recommendations for flexible and scalable educational CQA systems (Srba & Bielikova, 2016b).

Askalot is now in continuous use for 5 academic years (starting in 2013/2014) at the Faculty of Informatics and Information Technologies, Slovak University of Technology in Bratislava, Slovakia (FIIT STU). It is currently actively used in more than 50 computer science courses. In addition, it officially supports asking questions about organizational matters (i.e. the faculty management as well as the study department is involved).

The first usage of Askalot outside FIIT STU was at the Faculty of Sciences, University of Novi Sad, Serbia (FS UNS) as a part of cooperation project in SCOPES programme. More specifically, the local installation of Askalot at FS UNS was offered to bachelor second-year students of the course *Data Structures and Algorithm 2* in the winter semester of 2016/17 to be used in companion with the Moodle page of the course. Although the teacher and teaching assistants of the course were present on Askalot, the students were not obliged to register on Askalot and participate in discussions there. However, students active on Askalot obtained extra course points that were counted into the final grade.

Later on, Askalot system was also experimentally deployed at the Faculty of Informatics, University of Lugano, Switzerland (FI USI), where it was used within three courses, one bachelor course (*Web Atelier*) during the academic years 2017/2018 and 2018/2019 and two masters courses (*Business Process Modeling, Management and Mining* and *Software Architecture*) during the academic year 2017/2018.

For overall statistics about Askalot usage at all three institutions, please, see Table 1.

4. Methodology

The goal of this study is to evaluate and describe the potential of CQA systems in the context of university courses from the perspective of students. More specifically, we aim to evaluate students' perceptions and activity in the system and consequently determine the main characteristics of educational CQA systems and their suitability to be deployed in various settings (e.g. whether they can be used in one course only or can scale to support discussions across the whole faculty/university) and for various types of students (e.g. students with different group learning preferences).

We address the proposed goal with the following research questions:

RQ1 How do *different types of university students* in *various deployment settings* perceive: 1) the general *concept* of educational CQA systems, 2) core *features* of educational CQA systems, 3) particular *implementation* and user interface (UI) of Askalot CQA system?

RQ2 What are the *main characteristics* that influence the suitability of educational CQA systems for their deployment in university courses?

To answer the stated research questions, we utilize a statistical evaluation of questionnaire responses, which is further supported by data analyses of the datasets coming from the system itself (e.g. system usage logs).

4.1. Data collection and samples

For the purpose of the study, we use data from all three universities described in Section 3 (each university uses its own instance of the CQA system Askalot). These three universities are situated in different countries with slightly different cultural and educational settings. In addition, each university uses Askalot within a different number of courses, which are enrolled by a different number of students. Thanks to this high diversity, the study covers a variety of involved students, teachers and circumstances, in which knowledge sharing at universities can occur.

After the completion of the *Data Structures and Algorithm 2* course at FS UNS, the first version of questionnaire was designed and disseminated through the Moodle page of the course to the students in order to collect their attitudes and opinions about usage of educational CQA systems within university courses. Later on, relying on the Google Forms service, an extended version of the

[5] Demo of the CQA system Askalot is available at https://askalot.fiit.stuba.sk/demo. Source code of the CQA system Askalot is available at: https://github.com/AskalotCQA/askalot.

Table 1
Usage statistics of the Askalot CQA system at three universities where the study was held.

	Courses	Users	Questions	Answers	Comments	Votes	Question views
FIIT STU	51	1960	1176	1553	1609	9042	255 351
FS UNS	1	89	7	23	9	52	1357
FI USI	3	77	71	70	16	35	1675
Total	55	2126	1254	1646	1634	9129	258 383

questionnaire (with few additional questions which were added after analyses of the previously obtained answers from FS UNS) was disseminated to students from FIIT STU and FI USI. Students were able to submit answers in the questionnaire anonymously with a voluntary option to provide also their identity.

It can be seen that the questionnaire (Table A.7) consists of five parts:

1. The first part of the questionnaire (questions D_1 to D_7), in addition to general demographic questions (gender and year of study), contains questions where students indicate their level of activity on Askalot (e.g. registered active and registered passive students) and group learning or communication preferences.
2. The second part of the questionnaire (questions C_1 to C_5) addresses attitudes about the general concept of CQA systems in the context of university education.
3. The third part of the questionnaire (questions F_1 to F_6) is related to the core features typical for educational CQA systems.
4. The fourth part of the questionnaire (questions I_1 to I_4) is related to the evaluation of the Askalot implementation and its user interface.
5. Finally, the last part of the questionnaire (questions E_1 and E_2) contains broad open ended questions where students can give their comments about Askalot and suggestions regarding further improvements.

We want to emphasize that at all three institutions students were not obliged to register and use Askalot. Therefore, each respondent to our questionnaire belongs to one of the following three groups of students:

1. Registered active students (students who actively posted something on Askalot),
2. Registered passive students (students who have not asked questions and participated in discussions on Askalot, but have visited Askalot and used the knowledge provided by other classmates/teachers), and
3. Students who have not registered on Askalot.

In total, 182 students responded to our questionnaire. The largest sample of questionnaire responses (corresponding to the largest number of system users) was obtained from FIIT STU where 106 students (13 female and 93 male students) filled our questionnaire. Of these, 43 respondents (40.57%) are active students, 54 respondents (50.94%) are passive students and 9 respondents (8.49%) are students that have not registered on Askalot.

At FS UNS, we obtained responses from 43 second-year students (20 female and 23 male students): 10 respondents (23.25% of the total number) are active students, 19 respondents (44.19%) are passive students and 14 respondents (32.55%) are students that have not registered on Askalot at all.

The FI USI sample consists of 33 students (24 male and 9 female students): 20 respondents are active students (60.6%), 10 respondents are passive students (30.3%), while 3 respondents are students that have not registered on Askalot (9.1%).

4.2. Grouping students and data analysis methods

We divided questionnaire respondents into different groups according to several factors, which correspond to various deployment settings and students types.

Continual and sporadic students. Probably the most important factor influencing system usage (success) is its establishment in the institution (duration of deployment as well as the scope of involved courses). The influence of this factor is captured in our collected responses due to the important difference between the usage of Askalot at FIIT STU on the one side and at FS UNS and FI USI on the other side. Askalot at FIIT STU is used for more than 5 years and it is supported by FIIT STU teachers as one of organization-wide used e-learning systems. Secondly, it is widely accepted by students (the FIIT STU Askalot installation has approximately 2000 registered users) who created a critical mass of users causing the system's content to grow continually (currently, more than 1100 questions, 1500 answers and 1600 comments) and, consequently, attractive for new users. In other words, Askalot at FIIT STU is one of the main means for the communication among students, as well as between students and teachers, within a large majority of courses. On the other hand, Askalot at FS UNS and FI USI is still in an early, experimental phase of adoption with a small number of registered user (fewer than 100), a modest created content (fewer than 100 questions, answers and comments) and used in a small number of courses (fewer than three courses). Consequently, 182 respondents to our questionnaire can be divided into two independent groups:

1. 106 continual students (58.24%) from FIIT STU which are ”continually exposed” to Askalot within a large number of courses,
2. 76 sporadic students (41.76%) from FS UNS and FI USI that are ”experimentally exposed” to Askalot within a small number of courses.

Active and passive students. According to answers to question D_3, 156 registered students were divided into two categories reflecting their activity level in Askalot (as defined before):

1. 73 active students (46.8%), and
2. 83 passive students (53.2%).

In the case of non-anonymous questionnaire respondents, the validity of answers on D_3 have been positively verified by correlating provided answers with the real activity performed in Askalot (the real activity was obtained by retrieving students' online profiles in Askalot.

Online communication preferences. Questionnaire respondents from FIIT STU and FI USI were also asked about their online communication preferences with other colleagues and teachers (question D_7). In total, 130 students indicated their online communication preferences:

1. 81 students (62.31%) prefer to communicate using real-time discussions and chats (e.g. Facebook groups),
2. 39 students (30%) prefer CQA systems (e.g Askalot), and
3. Only 10 students (7.69%) indicated that standard discussion tools within learning management systems (e.g. Moodle forum) are their preferable way to communicate with colleagues and teachers.

Due to a small number of students who prefer communication using standard discussion tools provided by LMS, we decided to omit this group from further statistical analyses.

Group learning preferences. Question D_6 from our questionnaire enabled us to divide questionnaire respondents into independent groups according to group learning preferences. Out of 182 students:

1. 21 students prefer to learn always alone,
2. 86 students prefer to learn mostly alone, but sometimes also in groups,
3. 43 students prefer to learn equally alone and in groups,
4. 28 students prefer to learn mostly in groups, but sometimes also alone, and
5. 4 students prefer to learn always in groups.

It can be noticed that a small number of respondents (only 4 students which is less than 3% of the total number of respondents) prefer to learn always in groups. Thus, this group will be omitted when statistically comparing groups determined by group learning preferences.

Study years. Finally, questionnaire respondents from FIIT STU form the largest institutional subsample in our study. Moreover, this subsample contains students from all study years: 18 first-year students, 21 s-year students, 33 third-year students, 18 fourth-year students, 11 fifth-year students and 5 PhD students. Consequently, we investigated whether students' attitudes and opinions about educational CQA systems and Askalot depend on the study year (responses from PhD students were ignored in this analysis due to a small subsample size).

Besides general questions (D_1 to D_7), only the first part of the questionnaire (questions C_1 to C_5) was taken into account when analyzing collected responses of non-registered students, i.e. responses to questions related to CQA features and Askalot implementation were ignored for such students. Additionally, not all registered students gave answers to all questionnaire items.

In order to answer our RQ1, we employed a set of statistical techniques. Central tendencies in students' answers to 5-Likert scale questionnaire items (questions C_1 to C_5, F_1 to F_6 and I_1 to I_4) were identified by measuring their mean and median values. The variability in students' answers was measured by the standard deviation and IQR (interquartile range, the difference between the third and first quartile). To compare responses in two or more independent groups of respondents we employed distribution-free, non-parametric statistical methods suitable for samples of unequal size. Open-ended questions (D_4, D_5, E_1 and E_2) were evaluated manually.

The Mann-Whitney U (MWU) test (Mann & Whitney, 1947) and the Kolmogorov-Smirnov (KS) test (Feller, 1948) were used to detect whether there are statistically significant differences in responses to 5-Likert scale questionnaire items between two independent groups of respondents. The Mann-Whitney U test checks the null hypothesis that answers in one group do not tend to be either numerically higher (more positive) nor numerically lower (more negative) compared to answers in some other, independent group of respondents. On the other hand, the Kolmogorov-Smirnov test examines the null hypothesis that distributions of answers in two independent groups of respondents are equally distributed. Those two tests were used to examine differences in responses between: continual and sporadic students, active and passive students, and students with different online communication preferences.

The Kruskal-Wallis ANOVA test (Kruskal & Wallis, 1952) was used to examine differences in answers to 5-Likert scale questionnaire items for more than two independent groups of respondents. This test was namely employed to investigate whether there are statistically significant differences in opinions and attitudes among: respondents having different group learning preferences, and respondents at different study years.

Table 2
Statistical comparison of responses on questionnaire items between the group of continual and sporadic students.

	Continual students					Sporadic students					Statistical comparison				
Item	N	M	SD	Mdn	IQR	N	M	SD	Mdn	IQR	U	$p(U)$	D	$p(D)$	SSD
C_1	106	4.13	1.01	4	1	76	3.83	0.96	4	2	3187.5	0.01	0.17	0.13	**yes**
C_2	106	4.11	0.69	4	1	76	3.58	0.8	3	1	2486.5	0	0.37	0	**yes**
C_3	106	2.92	0.99	3	2	76	3.5	1.03	3	1	2747.5	0	0.24	0.01	**yes**
C_4	106	3.45	0.89	4	1	76	3.47	0.84	4	1	4003.5	0.94	0.06	0.98	no
C_5	106	1.92	0.85	2	1	76	2.24	1.02	2	2	3305	0.03	0.21	0.03	**yes**
F_1	93	4.25	0.72	4	1	26	3.77	1.07	4	2	913	0.04	0.18	0.43	**yes**
F_2	93	3.7	1.07	4	2	27	3.56	1.15	4	1	1178.5	0.62	0.07	1	no
F_3	93	3.73	1.01	4	2	27	3.78	1.01	4	2	1224	0.84	0.04	1	no
F_4	93	4.26	0.87	4	1	27	3.3	1.23	3	2	699	0	0.41	0	**yes**
F_5	92	3.85	0.85	4	1.75	27	3.78	1.12	4	2	1214	0.85	0.07	1	no
F_6	93	4.42	0.71	5	1	27	3.96	0.76	4	2	831.5	0	0.27	0.08	**yes**
I_1	96	4.11	0.69	4	1	58	4.07	0.77	4	1	2689.5	0.69	0.11	0.73	no
I_2	96	3.93	0.7	4	0	57	3.84	0.82	4	1	2562	0.46	0.13	0.54	no
I_3	96	3.93	0.74	4	0	59	3.92	0.65	4	0	2729	0.66	0.05	1	no
I_4	94	3.95	0.75	4	0	57	3.51	0.89	4	1	1925	0	0.25	0.02	**yes**

Note. The column "Item" denotes relevant questionnaire items. N – sample size (the number of students that gave an answer to the corresponding questionnaire item), M – mean, SD – standard deviation, Mdn – median, IQR – interquartile range, U – the Mann-Whitney test statistics, $p(U)$ – the p-value of U, D – the Kolmogorov-Smirnov test statistics, $p(D)$ – the p-value of D. The column "SSD" denotes whether there are statistically significant differences regarding corresponding questionnaire items between the compared groups.

The statistical analyses of students' perceptions captured by questionnaires were furthermore supported by descriptive data analysis techniques on datasets (activity logs) coming directly from the Askalot system. To a lesser extent, we manually evaluated the content created by students from all three universities (since the content was created in three different languages, automatic analyses would be quite challenging).

In order to answer our RQ2, we used all obtained findings from RQ1 as the source of evidence to derive and denominate the main characteristics of educational CQA systems.

5. Analyses of students' perceptions and activity

5.1. Continual and sporadic students

Relying on the MWU and KS tests, we firstly examined differences in attitudes between continual students (students from FIIT STU) and sporadic students (students from FS UNS and FI USI) towards the general concept of educational CQA systems, their core features and implementation of Askalot. The results of statistical testing are summarized in Table 2.

Concept. It can be observed that null hypotheses of MWU and KS tests are accepted only for questionnaire item C_4 ($p(U) \geq 0.05 \wedge p(D) \geq 0.05$). This means that there are no statistically significant differences between continual and sporadic students regarding the willingness of students to share on Askalot their questions and dilemmas related to course content with other colleagues (the central tendency in both groups is 4 which means that students from both groups are willing to share their questions and dilemmas on Askalot). For the rest of C questions we observed statistically significant differences between compared groups.

- Both continual and sporadic students agree with the usage of CQA systems within university courses (questionnaire item C_1, medians equal to 4), but continual students have a more positive attitude regarding this issue (Mean(continual) = 4.13 > Mean (sporadic) = 3.83, IQR(continual) = 1 < IQR(sporadic) = 2).
- Continual students agree that Askalot is an adequate place to seek for answers to questions and dilemmas related to course content (questionnaire item C_2), while sporadic students have a neutral attitude (Median(continual) = 4, Median(sporadic) = 3).
- Both continual and sporadic students tend to have a neutral opinion when Askalot is contrasted with personal or e-mail communication with teachers (questionnaire item C_3, medians equal to 3), but sporadic students tend to prefer the former mode of communication (Mean(sporadic) = 3.5 > Mean(continual) = 2.92, IQR(sporadic) = 1 < IQR(continual) = 2).
- Finally, both continual and sporadic students disagree that they would be more active on Askalot if teachers were not present on Askalot (questionnaire item C_5, medians equal to 2). However, continual students have a more positive attitude regarding the presence of teachers on Askalot (Mean(sporadic) = 2.24 > Mean(continual) = 1.92, IQR(sporadic) = 2 > IQR(continual) = 1).

Features. The questionnaire respondents from FIIT STU and FI USI also evaluated Askalot core features (questions F_1 to F_6 from the extended version of the questionnaire). It can be observed that continual students positively evaluated all Askalot core features (median equals to 4 or 5), while sporadic students positively evaluated all core features except F_4 (community voting on questions). Statistically significant differences between continual and sporadic students are present regarding the following core features:

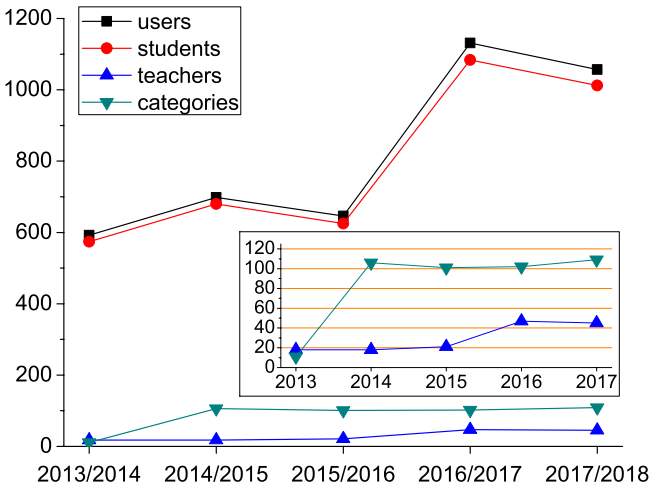

Fig. 1. Askalot yearly statistics at FIIT STU: the number of users (students and teachers together), students, teachers and categories. The inset provides a focused view of the number of teachers and categories per academic year.

- Both continual and sporadic students appreciate a possibility to publish different kinds of posts (questionnaire item F_1, medians equal to 4), but continual students evaluated this feature more positively (Mean(continual) = 4.25 > Mean(sporadic) = 3.77, SD (continual) = 0.72 < SD(sporadic) = 1.07, IQR(continual) = 1 < IQR(sporadic) = 2).
- Community voting on questions (questionnaire item F_4) is perceived as an useful feature by continual students, while sporadic students have a neutral opinion about this feature (Median(continual) = 4, Median(sporadic) = 3).
- Continual students more positively evaluated the highlighting of the content posted by teachers (questionnaire item F_6, Median (continual) = 5, Median(sporadic) = 4).

User interface. From the results of the evaluation of Askalot implementation and user interface by continual and sporadic students, it can be seen that there are no statistically significant and both continual and sporadic students agree that: Askalot is easy to use (I_1), it is easy to navigate through Askalot (I_2), and the content is visually well organized (I_3). Students from both groups also gave a positive overall evaluation of the Askalot UI, i.e. the median answer in both groups to question I_4 is that the Askalot UI is very good. However, there is a statistically significant difference between the groups:

- Continual students more positively evaluated the overall Askalot UI (I_4) when compared to sporadic students (Mean(continual) = 3.95 > Mean(sporadic) = 3.51, SD(continual) = 0.75 < SD(sporadic) = 0.89, IQR(continual) = 0 < IQR(sporadic) = 1).

The analysis of collected questionnaire responses on questionnaire item C_5 and F_6 indicated that both groups of students would not be more active on Askalot if teachers were not present on the system. Indeed, the activity logs of continual users at FIIT STU during the last 5 years clearly shows that the presence of teachers at Askalot is extremely important for students, causing the wide acceptance of the system in the students' community and its continual growth in content. Fig. 1 shows the total number of active Askalot users (students and teachers) recovered from the system activity logs and the total number of Askalot categories (each category corresponds to one course) from academic years 2013/2014 to 2017/18 (inclusively). The same figure also separately shows the total number of students and teachers. It can be observed that a large majority of Askalot users (more than 95% in each year) are actually students. Secondly, we can see that in 2016/2017 the number of students present on Askalot significantly increased compared to the previous academic year (625 students in 2015/2016 and 1084 students in 2016/2017). This large increase can be explained by the fact that the number of teachers present on Askalot doubled from 2015/2016 to 2016/2017 (21 registered teachers in 2015/2016 and 47 registered teachers in 2016/2017). The number of Askalot categories increased previously from 11 in 2013 to 106 in 2014 and remained stable afterwards. This means that adding support to ask questions in new categories (courses) itself did not make the system more attractive to students. However, only the later increase of teachers present on the system directly caused the large increase of students active on the system.

In terms of content (Fig. 2), we can see that the number of questions and answers was slowly decreasing during first three academic years. This can be explained by extrinsic motivation (extra course points for active students) provided by teachers during the first academic year and to a lesser extent during the second academic year. Afterwards, the previously mentioned large increase in the number of active students was followed by even more significant increase in the content available on the system: the number of questions increased by 3.7 times from 2015/2016 to 2016/2017, the number of answers 3.52 times, while the number of comments increased by 3.55 times. Fig. 3 shows the fraction of questions, answers and comments made by students. As expected, a vast majority of questions (more than 92% in each year reaching 99.28% in 2017/2018) were posted by students. On the other side, the number of answers is fairly balanced between students and teachers implying that teachers were actually very active on the system taking into account their relative number (less than 5% of the total number of active users). Consequently, it can be concluded that the presence

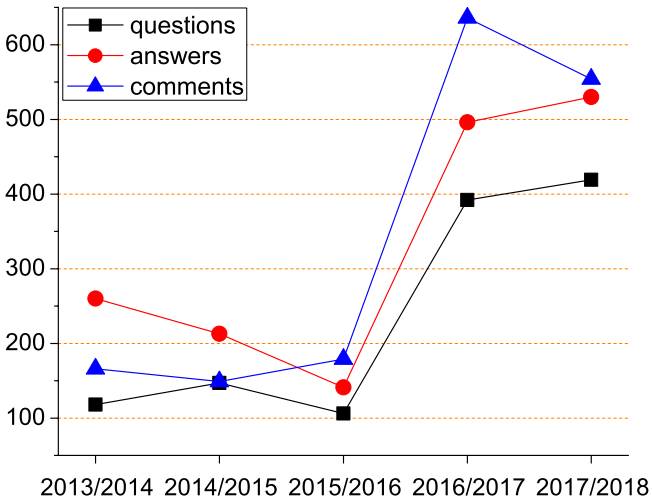

Fig. 2. Askalot yearly statistics at FIIT STU: the number of questions, answers and comments.

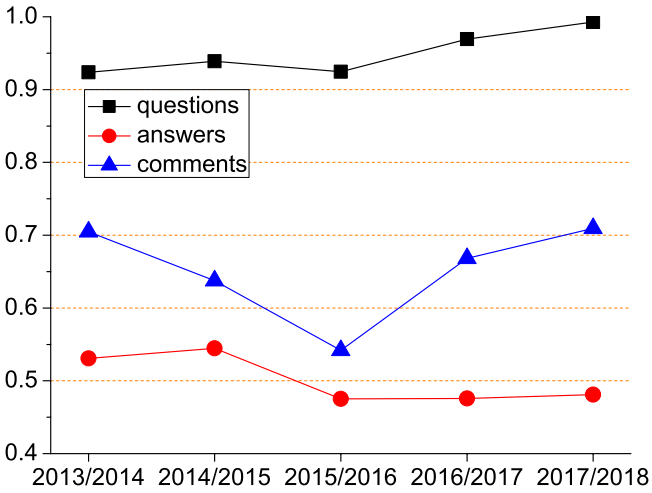

Fig. 3. Askalot yearly statistics at FIIT STU: the fraction of questions, answers and comments made by students.

of active teachers on Askalot has a profound impact on the number of students using the system and its continual growth.

5.2. Active and passive students

The results of statistical comparison of active and passive students are summarized in Table 3. It can be seen that the null hypotheses of the MWU and KS tests are accepted for a large number of questionnaire items.

Concept. Statistically significant differences between active and passive students are absent for questionnaire items C_1 (students from both groups agree that CQA systems should be used within university courses), C_2 (students from both groups agree that the CQA system is an adequate place to seek for answers to questions and dilemmas related to course content) and C_5 (students from both groups disagree that they would be more active on Askalot if teachers were not present there). Statistically significant differences between active and passive students are present regarding questionnaire items C_3 and C_4:

- Both active and passive students tend to have a neutral attitude when Askalot is compared with personal or e-mail communication with teachers (questionnaire item C_3, medians equal to 3). However, passive students tend to prefer personal/e-mail communication more than active students (Mean(passive) = 3.34, Mean(active) = 2.75).
- Active students are more willing to share their questions and dilemmas related to course content on Askalot (questionnaire item C_4, Median(active) = 4, Median(passive) = 3).

Previously mentioned statistically significant differences between active and passive students are not surprising since they can be explained by the fact that active students have more proactive attitudes towards Askalot than passive students.

Table 3
Statistical comparison of responses on questionnaire items between the group of active and passive students.

Item	Active students					Passive students					Statistical comparison				
	N	M	SD	Mdn	IQR	N	M	SD	Mdn	IQR	U	$p(U)$	D	$p(D)$	SSD
C_1	73	4.14	1.07	4	1	83	4.04	0.92	4	2	2692	0.2	0.15	0.29	no
C_2	73	4.01	0.81	4	1	83	3.93	0.76	4	1	2783	0.34	0.09	0.91	no
C_3	73	2.75	1	3	1	83	3.34	0.89	3	1	2016.5	0	0.24	0.02	**yes**
C_4	73	3.78	0.71	4	1	83	3.36	0.82	3	1	2205.5	0	0.22	0.04	**yes**
C_5	73	2.08	0.95	2	2	83	1.89	0.9	2	2	2702.5	0.22	0.09	0.83	no
F_1	61	4.08	0.9	4	1	58	4.21	0.74	4	1	1676	0.6	0.05	1	no
F_2	62	3.71	1.08	4	1.25	58	3.62	1.11	4	1.25	1714.5	0.65	0.06	1	no
F_3	62	3.66	0.99	3	2	58	3.83	1.03	4	2	1601.5	0.28	0.15	0.42	no
F_4	62	3.94	1.14	4	2	58	4.16	0.91	4	1	1660	0.44	0.13	0.59	no
F_5	61	3.77	0.96	4	1	58	3.9	0.87	4	2	1663.5	0.56	0.05	1	no
F_6	62	4.26	0.72	4	1	58	4.38	0.77	5	1	1602	0.26	0.13	0.61	no
I_1	73	4.18	0.63	4	1	80	4.04	0.79	4	1	2701.5	0.37	0.05	1	no
I_2	72	3.94	0.75	4	0	80	3.86	0.74	4	0.75	2702.5	0.46	0.04	1	no
I_3	73	3.89	0.74	4	0	81	3.96	0.68	4	0	2818.5	0.56	0.05	1	no
I_4	73	3.74	0.83	4	1	78	3.82	0.83	4	1	2656	0.44	0.09	0.91	no

Features and User interface. It can be seen that the null hypotheses of the MWU and KS tests are accepted for all F and I questionnaire items. This means that there are no statistically significant differences in the evaluation of the CQA core features and Askalot implementation between active and passive students. Additionally, both active and passive students think that the core features are assessed as very useful, while the Askalot implementation and its UI is very good.

5.3. Online communication preferences

The results of the statistical comparison of students with different online communication preferences are summarized in Table 4. Students from the both groups agree that CQA systems should be used within university courses and both groups positively evaluated the Askalot user interface without statistically significant differences in given opinions.

Concept. Similarly as in the comparison of active and passive students, the statistically significant differences are present regarding two questionnaire items related to the CQA concept (C_3 and C_4).

- Students preferring real-time discussions and chats tend to have a neutral attitude when Askalot is compared with personal and e-mail communications with teachers (questionnaire item C_3). On the other hand, students preferring CQA systems to communicate with teachers would rather approach them using this kind of system rather than personally or via e-mail (Median(real-time) = 3, Median(CQA) = 2).
- Students preferring real-time discussions also tend to have a neutral attitude regarding posting on Askalot (questionnaire item C_4). As expected, students preferring CQA systems are also more willing to post on Askalot (Median(real-time) = 3, Median (CQA) = 4).

Table 4
Statistical comparison of responses on questionnaire items between the students having different online communication preferences.

Item	Real-time discussions/chats					CQA systems					Statistical comparison				
	N	M	SD	Mdn	IQR	N	M	SD	Mdn	IQR	U	$p(U)$	D	$p(D)$	SSD
C_1	81	4.09	0.98	4	2	39	4.03	1.16	4	1	1569	0.95	0.05	1	no
C_2	81	3.96	0.77	4	0.5	39	4.1	0.75	4	1	1396	0.26	0.12	0.8	no
C_3	81	3.2	1.05	3	1.5	39	2.59	0.91	2	1	1063.5	0	0.27	0.04	**yes**
C_4	81	3.31	0.8	3	1	39	3.87	0.73	4	0	989.5	0	0.31	0.01	**yes**
C_5	81	2.05	0.93	2	2	39	1.79	0.77	2	1	1349	0.17	0.17	0.4	no
F_1	66	4.06	0.84	4	1.25	38	4.29	0.84	4	1	1040.5	0.12	0.14	0.67	no
F_2	67	3.57	1.06	4	1	38	3.92	1.17	4	2	1002.5	0.06	0.2	0.24	no
F_3	67	3.66	1.07	4	2	38	3.79	1.02	4	2	1196	0.59	0.06	1	no
F_4	67	4.03	1.04	4	1	38	4.08	1.05	4	1.25	1230	0.76	0.04	1	no
F_5	67	3.67	0.98	4	1	37	3.95	0.85	4	1	1020.5	0.12	0.22	0.17	no
F_6	67	4.39	0.76	5	1	38	4.29	0.69	4	1	1145.5	0.35	0.14	0.64	no
I_1	71	4.08	0.65	4	0	39	4.05	0.69	4	0	1358.5	0.85	0.01	1	no
I_2	70	3.9	0.64	4	0	39	3.87	0.8	4	0	1338.5	0.85	0.04	1	no
I_3	71	3.97	0.65	4	0	39	3.85	0.78	4	0	1287	0.48	0.06	1	no
I_4	70	3.83	0.78	4	1	39	3.79	0.86	4	1	1331.5	0.82	0.08	0.99	no

Table 5
Statistical comparison of responses on questionnaire items between the students having different group learning preferences.

Item	N(G_1)	M(G_1)	N(G_2)	M(G_2)	N(G_3)	M(G_3)	N(G_4)	M(G_4)	H	p	SSD
C_1	21	3.86	86	3.91	43	4.16	28	4.07	3.11	0.38	no
C_2	21	3.62	86	3.81	43	4	28	4.07	5.28	0.15	no
C_3	21	3.48	86	3.06	43	3.19	28	3.18	2.17	0.54	no
C_4	21	3	86	3.47	43	3.7	28	3.46	9.01	0.06	no
C_5	21	2.1	86	2.01	43	2.09	28	2.11	0.39	0.95	no
F_1	7	4	59	4.15	29	4	21	4.33	1.39	0.72	no
F_2	7	3.86	60	3.8	29	3.48	21	3.62	1.81	0.62	no
F_3	7	3.86	60	3.93	29	3.52	21	3.52	4.19	0.24	no
F_4	7	4.29	60	3.97	29	4	21	4.14	0.76	0.87	no
F_5	7	3.86	59	3.81	29	3.97	21	3.67	1.94	0.59	no
F_6	7	4.57	60	4.28	29	4.28	21	4.33	0.91	0.83	no
I_1	13	4	74	4.05	38	4.11	26	4.23	1.47	0.7	no
I_2	13	3.92	74	3.91	37	3.89	26	3.85	0.66	0.89	no
I_3	14	3.93	74	3.88	38	3.95	26	3.96	0.95	0.82	no
I_4	14	4.14	73	3.74	36	3.58	25	3.96	5.04	0.17	no

Note.G_1 – students preferring to learn always alone, G_2 – students preferring to learn mostly alone, but sometimes also in groups, G_3 – students preferring to learn equally alone and in groups, and G_4 – students preferring to learn mostly in groups, but sometimes also alone. H – the Kruskal-Wallis ANOVA test statistic, p – the p-value of *ANOVA*. The column "SSD" denotes whether there are statistically significant differences between students having different group learning preferences regarding corresponding questionnaire items. N(G_i) denotes the number of students from G_i who gave an answer to the corresponding questionnaire item, while M(G_i) is the mean value of answers.

Features and User Interface. The null hypotheses of the MWU and KS tests are accepted for all F and I questionnaire items. This means that there are no statistically significant differences in the evaluation of the CQA core features and Askalot implementation between students having different online communication preferences.

5.4. Group learning preferences

Using the Kruskal-Wallis ANOVA statistical test we examined whether general students' attitudes towards the concept of CQA systems and the evaluation of the Askalot features and user interface depend on the way students prefer to learn and prepare exams. The obtained results are summarized in Table 5. It can be seen that statistically significant differences are absent for all questionnaire items. Consequently, it can be concluded that students' attitudes about CQA systems and Askalot in particular are independent of group learning preferences.

Additionally, both individual and group learners positively evaluated the CQA core features and Askalot implementation (the mean value of responses to questions I_1 to I_4 and F_1 to F_6 in all cases is higher than or very close to 3.5).

5.5. Study years

The results of statistical testing between different groups of FIIT STU students created according to study years based on the Kruskal-Wallis ANOVA test are presented in Table 6.

Concept. Statistically significant differences are absent regarding questions C_1 to C_3 and C_5. Students from all study years agree

Table 6
Statistical comparison of responses on questionnaire items between the continual (FIIT STU) students from different study years.

Item	N(G_1)	M(G_1)	N(G_2)	M(G_2)	N(G_3)	M(G_3)	N(G_4)	M(G_4)	N(G_5)	M(G_5)	H	p	SSD
C_1	18	4.5	21	4.19	33	3.97	18	3.89	11	4.18	5.11	0.27	no
C_2	18	4.22	21	4.24	33	4.12	18	3.83	11	4	3.37	0.5	no
C_3	18	2.61	21	2.67	33	2.91	18	3.06	11	3.64	7.95	0.09	no
C_4	18	3.72	21	3.71	33	3.48	18	3.11	11	2.82	11.25	0.02	**yes**
C_5	18	1.83	21	2.19	33	1.79	18	1.83	11	2.09	2.59	0.64	no
F_1	15	4.47	19	4.21	33	4.12	13	4.08	8	4.62	5.13	0.27	no
F_2	15	3.93	19	3.53	33	3.85	13	3.54	8	3.38	2.79	0.6	no
F_3	15	4	19	3.47	33	3.52	13	3.77	8	4.25	5.62	0.23	no
F_4	15	3.8	19	4.58	33	4.15	13	4.23	8	4.5	7.36	0.11	no
F_5	15	4.07	19	3.79	32	3.84	13	3.62	8	3.62	2.78	0.6	no
F_6	15	4.4	19	4.47	33	4.36	13	4.62	8	4.12	3.54	0.48	no
I_1	16	4	20	4.1	33	4	14	4.14	8	4.62	6.55	0.16	no
I_2	16	3.81	20	3.7	33	3.97	14	4.07	8	4.12	3.86	0.43	no
I_3	16	3.88	20	4	33	3.82	14	4.14	8	4	2.37	0.68	no
I_4	16	4	20	3.85	32	3.81	14	4	7	4.29	4.89	0.3	no

Note.G_i denotes the group of students that are at i-th year of study.

that CQA systems should be used within university courses and they are nominally willing to use them without feeling any strong pressure by the presence of teachers on such systems. The only questionnaire item for which statistically significant differences in opinions of students from different study years are observed is question C_4. For this question we have performed the pair-wise comparison of the subsample determined by the study year using the MWU test with Bonferroni correction.

- The post-hoc testing procedure revealed that first-year students are significantly more willing to share their questions and dilemmas on Askalot compared with the fifth-year students ($U = 46.5$, $p = 0.0097$).

Features and User interface. It can be observed that there are no statistically significant differences in the evaluation of the CQA core features and Askalot implementation among students from different study years. The mean value of responses to questions F_1 to F_6 and I_1 to I_4 is in all cases higher than or very close to 3.5 which means that students from all study years positively evaluated the CQA core features and Askalot implementation.

5.6. Qualitative evaluation

The questionnaire used to collect students' opinions and attitudes also contains questions where students can indicate why they have not registered and used Askalot (D_4) and why they have not used it more actively (D_5). A very large fraction of FIIT STU respondents are registered students. In contrast to FIIT STU respondents, a considerable fraction of respondents from FS UNS are students who have not registered on Askalot. As the main reason for not registering on Askalot such students indicate the need to register with a dedicated account which means that they need multiple, independent accounts for services provided by different e-learning platforms used to support teaching. Passive students indicated the following reasons for being passive on Askalot:

- Questions they had were already asked and answered by other students and teachers.
- No specific questions to ask on Askalot.
- Their personality (shyness, the fear of "stupid" questions and answers, etc.).
- Some students consider personal or real-time communication faster and more efficient.
- Anonymity concerns (some students were not sure whether anonymous communication on Askalot is really anonymous).

Finally, questionnaire respondents were in a position to indicate what they particularly like on Askalot and how it can be improved (questions E_1 and E_2). A large fraction of students responding to E_1 and E_2 actually indicated that the presence of teachers on Askalot is really important to them and that communication with teachers is one of the main reasons for using Askalot.

6. Deriving characteristics of educational CQA systems

Following the obtained findings from statistical analyses of students' perceptions supported by analyses of user activity logs and created content, we derived a set of main characteristics which describe educational CQA systems and their potential to be deployed in various settings and their suitability for various types of students.

Variability in a number of courses and students. At first from the obtained results, we identified a high scalability of educational CQA systems. While standard forums are criticized because of losing clarity and efficiency for large number of students and diverse topics (Almatrafi & Johri, 2018), CQA systems can scale better. It is true not only with large numbers of students (Askalot at FIIT STU involved almost 2000 students), but also in terms of courses (Askalot at FIIT STU handles communication within more than 50 courses). The very wide deployment, however, does not have a negative influence on the answer rate, since 1104 out of 1176 questions (94%) are successfully answered (in addition a part of remaining questions may be answered as well but the answers were incorrectly provided in comments instead of dedicated answers). Besides large-scale deployment, we can see that our CQA system was positively perceived by students also in cases when it was used only by few (1–3) courses.

Flexibility in question types and topics. By consideration of the FIIT STU institution, we can confirm that CQA systems can handle various types of questions also outside the scope of standard university courses. We can witness a quite significant number of questions (277, 23.55%) that are related to various organizational matters (e.g. proposals how to improve exam organization).

Readiness for long-term deployment. CQA systems were designed to be archives of valuable content (solved question-answer pairs). We showed an expected result that continual students (FIIT STU) appreciate this feature significantly more than sporadic students. Thanks to simple navigation in categories and tags (reflecting academic years and courses), Askalot allows students to easily reuse the knowledge from previous years. It can be well illustrated through activity logs from FIIT STU, where 1004 out of 1960 students (51%) 11 311 times rediscovered a knowledge from the past by visiting a question, which was asked and answered during one of previous academic years.

Supporting different levels of participation. Comparison of opinions by active and passive students showed that CQA systems are suitable not only for actively contributing students (who create new questions, answers or comments), but also for more passive students. These lurking users are not restricted only to reading existing content, but they can participate semi-actively by voting, favoring or watching categories or specific questions.

Independence on group learning preferences and study years. As additional comparisons showed, students' attitudes about CQA systems and Askalot in particular are independent of group learning preferences and study years. We noticed that especially younger students considered the CQA system as helpful, which is natural since these students have usually more questions than

students in higher study years.

Supporting collective and effective communication with teachers. Students' perceptions as well as data analyses confirmed that the involvement of teachers in the question answering process is very important. The results suggest that the twofold increase in the number of teachers can result in almost 4-times more questions and answers. Students appreciate especially a collective communication with teachers, which is hardly possible in person or by email (at FIIT STU, some questions have even more than 150 positive votes illustrating their extreme importance). Moreover, students' participation contributes to lesser overload of teachers. We observed that many questions were successfully answered by students themselves. Especially in the case of continual deployment, 730 out of 1553 answers (47%) were provided by students. In many cases, the questions of younger students were answered by their older classmates, which shows us the advantage of involving students from different study years.

Besides positive attitudes to the concept of educational CQA systems, the study also revealed two additional characteristics based on students' perceptions of CQA core features.

Well arranged content. First, students appreciate good organization of content within the scope of the whole system (categorization of questions, which corresponds to study years, courses, course parts) and in the scope of each discussion thread - clear division between a question (a problem definition), an answer (a solution) and comments (additional information).

Ubiquitous workspace awareness. In comparison with standard forums, a better workspace awareness is typical for CQA systems. This assumption was confirmed by students too as they evaluated especially positively the dashboard overview of recent activity and a complex notification system.

Last but not least, we identified few drawbacks and open problems that are present in educational CQA systems.

A long and difficult way to achieve continual deployment. As the study reveals, educational CQA systems provide students the most advantages when they are used in continual settings (i.e. in several courses, with students from different study years, in a long-term way). However, it is necessary to say that achieving this kind of deployment at FIIT STU required a great deal of effort from teachers who actively promoted Askalot, answered questions, etc. All this effort, however, finally resulted in the state in which Askalot became self-managed, well-accepted and recognized by students.

Asynchronous character of communication. Some students in our study, prefer to communicate by means of synchronous real-time tools (e.g. chats or Facebook groups). These students consider the asynchronous character of CQA systems as too slow especially in cases when they need to communicate with classmates more intensively (e.g. when solving questions about assignments with approaching deadline). In these cases, employment of CQA systems seems to be not very effective and various chats or social networking sites seem to be more appropriate. A similar problem is, however, present in standard forums as well due to their similar asynchronous character.

Integration issues. In the case of FS UNS and FI USI students, we noticed the complaint that it was necessary to create a separate account to participate in the CQA system. This implementation problem can be solved, however, very easily for example by setting up an integration with university single-sign on or LDAP server (as it is done in the case of FIIT STU).

Privacy and anonymity concerns. Finally, the answers on open-ended questions pointed out another problem related to privacy and anonymity. Despite the fact that Askalot provides a support for asking question anonymously (to minimize students' fear of asking any kind of question and providing also a critical feedback on educational process), some students still perceive that this kind of anonymization is not sufficient. Making user profiles completely anonymous was, however, previously associated with a higher deviance in user behaviour (spreading of various less-constructive content and rules violation) in comparison with non-anonymous or semi-anonymous user profiles (Kayes, Kourtellis, Bonchi, & Iamnitchi, 2015). Finding an appropriate level of anonymization thus represents an interesting open problem, which is not characteristic for CQA systems only.

Out of the previously described characteristics, some are enabled by the concept of CQA systems in general (i.e. these characteristics are present also in well-known non-educational CQA systems on the open web, such as Stack Overflow or Yahoo! Answers). It means, that the non-educational CQA systems can be used in the educational domain quite successfully as well (e.g. instructors at edX online course CS50 used the StackExchange platform[6]). Nevertheless, these non-educational CQA systems may not always achieve the best results, since educational usage is not completely compatible with their features, rules and expectations.[7] For example, some students' questions may be subjective or too specific (e.g. related to a specific part of learning materials or assignments), or students are naturally transient and thus they cannot build the stable core community, which is expected in this kind of systems.

In addition, some characteristics are typical for educational CQA systems only. Namely, taking teachers into consideration (e.g. highlighting of their contributions, or providing a possibility to evaluate students' questions/answers at 5-point Likert scale) contributes to the fact, that teachers' presence in educational CQA systems is perceived by students positively and encourage further students' participation. It finally causes that CQA systems may serve as means for *collective and effective communication with teachers*. Secondly, educational-specific hierarchical organization of categories and tags (reflecting academic years, courses and their structure, e.g. lectures, seminars, projects and assignments) contributed to CQA systems being *ready for long-term deployment* with *well arranged content*.

Educational CQA systems are designed with students and their learning in mind and thus they also naturally address drawbacks present in non-educational CQA systems. Moreover, they also provide all positive characteristics identified in this study. This confirms that they should be used in the educational domain preferably.

[6] https://cs50.stackexchange.com/.

[7] https://meta.stackexchange.com/questions/260406/what-do-you-think-of-a-set-of-stack-exchange-sites-for-universities/260436.

7. Conclusions

Online discussions in university courses or MOOCs are typically held by means of standard forums. These forums, however, have some drawbacks which may hinder effective knowledge sharing between students and teachers in some conditions (e.g. in the case of large and diverse communities of students, who may have various motivations, or in courses with majority of logistical and fact-based questions). All these factors may result in standard forums not being optimal discussion tools. In this study, we therefore focus on less common alternatives for mediating online discussions, which seems to be more appropriate in such settings - educational Community Question Answering (CQA) systems.

Our goal was to analyze students' perspectives in order to determine the main characteristics of educational CQA systems and their potential for supporting communication in university courses. For this purpose, we conducted a large-scale mixed quantitative and qualitative study in which we collected perceptions from 182 CS students at three universities in three different countries. The obtained findings enabled us to identify a set of 12 main characteristics, which specify in which settings and for which types of students educational CQA systems are suitable to be deployed.

In general, we can conclude that students have positive attitudes towards educational CQA systems with the implementation of Askalot in particular being an example of this kind of system. In contrast with standard discussion forums, CQA systems seem to be better prepared for large numbers of students/questions and for long-term deployment when valuable knowledge stored in discussions from the previous academic years can be efficiently reused. These advantages are important especially in the case of continual and organization-wide deployment, nevertheless we can confirm that positive characteristics of CQA systems were recognized also in significantly smaller deployments with 1–3 courses and students numbers below 100. In addition, we showed that CQA systems are applicable for a variety of learners (in terms of their activity level, learning preferences, study years). Finally, we found out that the teachers' presence in the system is perceived by students positively and significantly encourage their participation.

This study was conducted specifically on computer science (CS) courses. It can be expected that CS students have better skills with information and communication systems and they may have also a more extensive prior experience with CQA systems, which are quite popular on the open Web (e.g. Stack Overflow). Thus they are naturally good candidates to become the first adopters of novel technologies, while educational CQA systems are not an exception. However, we would like to emphasize that students evaluated CQA features and user interface as easy to use and navigate. These characteristics represent a necessary precondition to be adapted also by students from other areas, where standard forums may also not be an optimal solution.

There are several possibilities for future research directions. At first, it would be possible to complement this study with the perspectives of teachers, who are using educational CQA systems and eventually compare these with their experiences with standard forums. Moreover, educational CQA systems are starting to be used more extensively in MOOCs as well. An in-depth complex study comparing CQA systems and standard forums in terms of quality and quantity of contributions in MOOCs represents another interesting option for future research.

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Appendix A. Questionnaire

Table A.7
Questionnaire used to collect students' attitudes and opinions about the usage of CQA systems in university courses and particular implementation of the CQA system Askalot. Extended questionnaire (used at FIIT STU and FI USI) was supplemented with one question addressing students' online communication preferences (D_7), questions related to the evaluation of the most important Askalot features (F_1 to F_6), and open form questions (E_1 and E_2).

Item	Question
D_1	Gender (Male/Female)
D_2	Year of study
D_3	I belong to the following group (please select exactly one group): 1. I have not registered on Askalot 2. I have registered, but I have not used Askalot (I have not asked questions and participated in discussions) 3. I have registered and used Askalot
D_4	If you have not registered on Askalot, is there any special reason for that?

(*continued on next page*)

Table A.7 (*continued*)

Item	Question
D_5	If you use Askalot only passively, is there any special reason why you have not used it actively?
D_6	I prefer to study and prepare exams (please select one answer): 1. Always alone 2. Mostly alone, but sometimes also in groups with other colleagues 3. Equally alone and in groups 4. More frequently in groups than alone 5. Always in groups
D_7	I prefer to communicate online with other classmates/teachers by 1. Standard discussion, such as discussion in Moodle 2. Real-time discussion/chat, such as Facebook groups 3. Community question answering, such as Askalot
C_1	Platforms like Askalot should exist within university courses? (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
C_2	Platforms like Askalot are an adequate place to seek for answers to questions and dilemmas related to the content of university courses? (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
C_3	I would ask questions related to the course content directly teachers (personally or via e-mail) rather than posting them on Askalot? (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
C_4	If I had questions and dilemmas related to the course content I would share them with other colleagues on Askalot? (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
C_5	I would be more active on Askalot if teachers were not present on Askalot. (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
F	Which features of Askalot did you find useful - on a scale from 1 (completely useless) to 5 (extremely useful)?
F_1	Providing different kinds of posts – questions, answers, and comments
F_2	The dashboard overview of recent activity
F_3	Notifications about ”watched” questions/categories (delivered in Askalot or by email)
F_4	Community voting on questions
F_5	Providing different question types (general question, mistake report, feedback request, etc.)
F_6	The highlighting of questions/answers/comments that were posted by teachers
I_1	Askalot is easy to use. (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
I_2	It is easy to navigate through Askalot and its core features are easily accessible in each moment. (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
I_3	The content on Askalot is visually well organized. (1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
I_4	The overall grade for the Askalot user interface would be: (1) Unsatisfactory (2) Satisfactory (3) Good (4) Very good (5) Excellent
E_1	What do you like about Askalot?
E_2	What we can do to make Askalot better? Do you have any other comments or suggestions?

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